

The Living Environment

- ✓ Diversity of Life
- ✓ Heredity
- ✓ Cells
- ✓ Interdependence of Life
- ✓ Flow of Matter and Energy
- ✓ Evolution of Life
- ✓ Forces of Nature

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THE LIVING ENVIRONMENT - Diversity of Life
Grade K-2 (Benchmark 1 of 3)

By the end of 2nd grade all students will know that --

Some animals and plants are alike in the way they look and in the things they do, and others are very different from one another.

Suggested Activity:

Comparing leaves collected from the school playground.

Embedded Assessment: Sorting different kinds of leaves.

Summative Assessment: Sorting other things, i.e. nuts, shells, flowers
pets, animals.

Theme: Constancy and Change

Process: Manipulating Information, esp. classifying

From Ms. McGuirl's First Grade Class, Oak Haven School, Coventry ...

*Science should begin in kindergarten with students learning to work in small teams, rather than as isolated individuals. Students should ask and answer questions about their surroundings and share their findings with classmates. Praise should be given for curiosity and creativity even when the investigations they lead to do not turn out as planned. Ms. McGuirl's first graders use the 'mystery object' format. Students need access to a hand lens, forks, toothpicks and napkins for this activity, and the 'mystery object' along with a more familiar (but related) object. Last year, Ms. McGuirl used a chestnut burr with the class, and provided acorns for comparison. This activity is usually done over two days. The first day involves a discussion of what the 'mystery object' is, where it comes from, and what you do with it. Students are permitted to observe, dissect, and explore the object in small groups. Discussion and guessing are encouraged among the small groups. To bring closure on the first day, Ms. McGuirl and her class read *The Tree, A First Discovery Book* together. The second day, students go out and find maple seeds in the playground. The seeds are collected and compared. Again working in small groups the students discuss how the seeds are similar or different. Ms. McGuirl recommends Lois Ehlert's *Red Leaf, Yellow Leaf* to complement this second day. During this activity, the teacher encourages students to notice how parts of plants are similar in many ways, and different in others. Children are encouraged to compare the 'mystery object' to similar items they know about, and to share this knowledge with the class.*

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THE LIVING ENVIRONMENT - Diversity of Life
Grade K-2 (Benchmark 2 of 3)

By the end of 2nd grade all students will know that --

Plants and animals have features [adaptations] that help them live [survive] in different environments.

Suggested Activity:

Observing animal adaptations, using pictures, live animals (pets, trip to zoo or farm). Provide students with replicas of animal feet. Students observe features of feet and relate them to the animals' survival in the environment (food-gathering, defense, etc.) Another activity might be to design a real or imaginary aquarium or terrarium.

Embedded Assessment:	During discussion, students are able to match features with environments (e.g., webbed feet with water).
Summative Assessment:	Design a creature given a particular environment. Relate features of a creature to the creature's survival in that environment.
Theme:	Systems
Process:	Manipulating Information, esp. developing generalizations

"Feet" are available from NASCO or Museum Products. Roger Williams Park Zoomobile "What's In My Lunchbox" program is useful. Farms: Dame Farm on Brown Ave. in Johnston, Watson Farm in Jamestown, and Coggeshall Farm in Bristol.

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THE LIVING ENVIRONMENT - Diversity of Life
Grade K-2 (Benchmark 3 of 3)

By the end of 2nd grade all students will know that --

Stories sometimes give plants and animals attributes they really do not have.

Suggested Activity:

Use a story and separate fact from fiction. Can animals really talk? Fairy tales, Disney stories, or Magic School Bus stories may all work well.

Embedded Assessment: Children discuss how the story is different from reality.

Summative Assessment: Compare a fantasy animal or plant (like Peter Rabbit or Roger Rabbit) to the real thing, or to actual photos.

Theme: Models

Process: Manipulating Information, esp. interpreting/evaluating data

From Ms. Andrews First Grade Class, Clayville Elementary School, Scituate ...

Ms. Andrews takes advantage of her first-graders interest in 'spooky' things during the week preceding Halloween. One afternoon following recess she and her class sat down to talk about bats. First students were asked what they knew about bats. As each child spoke in turn they had the chance to share with the class their knowledge and experience of bats. This evolved naturally into a discussion about the reputation of bats, and the diversity of bats (and 'bat-stories'!) around the world. Ms. Andrews was prepared with a variety of cardboard Halloween decorations depicting bats. She would hold them up as the discussion progressed, asking "does a bat really look like this?" or "why do you suppose haunted houses are always shown with bats?". Eventually the class agreed that many stories about bats, and many pictures of bats, have very little to do with real bats. To focus and review the real-life attributes of bats, Ms. Andrews reads the non-fiction book Bats to the class. Students have the opportunity to comment on the facts presented in the book, and the general body of knowledge about bats continues to grow. As a culminating activity the class works together to label the anatomical features of a model brown bat.

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THE LIVING ENVIRONMENT - Diversity of Life
Grade 3-5 (Benchmark 1 of 2)

By the end of 5th grade all students will know that --

A great variety of kinds of living things can be sorted into groups in many ways using various features to decide which things belong to which group.

Suggested Activity:

Play "Guess My Rule". Using a collection of invertebrates (insects, crustaceans, mollusks, etc.) students group and regroup them according to 'rules' that make sense to them. Students use evidence, based on physical properties, to defend and explain their rules. This game could also be played using leaves, nuts, bark, shells, flowers, and so on. Explore how a supermarket is organized, and what the supermarket's 'rules' for grouping are.

Embedded Assessment:

Observe students to see if the 'rules' are based on physical properties and observable characteristics. Have students explain and justify their rules (classification) to other students. Have students develop a conceptual map of how items in a collection are related to one another.

Summative Assessment:

Given a collection of 10-15 animals (invertebrates) the students will group them in at least three different ways and explain the rules for their groupings.

Theme:

Constancy and Change, Systems

Process:

Manipulating Information, esp. classifying

If you are collecting marine organisms from the shore, remember that a Scientific Collectors Permit may be required if you collect out of season, illegal sizes or from restricted areas. If you have any doubts, please check with Dick Sisson of DEM at 277-3075.

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THE LIVING ENVIRONMENT - Diversity of Life
Grade 3-5 (Benchmark 2 of 2)

By the end of 5th grade all students will know that --
Features used for grouping depend on the purpose of the grouping.

Suggested Activity:

Students classify (group) a collection of plant foods obtained from the garden or the grocery store and explain how their groupings are personally useful.

Embedded Assessment: Students explain the utility of their grouping.

Summative Assessment: On a walk around the school building, the student(s) will group ten different plants identified by the teacher and explain their groupings based upon their degree of usefulness.

Theme: Constancy and Change

Process: Manipulating Information, esp. classifying

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THE LIVING ENVIRONMENT - Diversity of Life
Grade 6-8 (Benchmark 1 of 5)

By the end of 8th grade all students will know that --

One of the most general distinctions among organisms is between plants, which use sunlight to make their own food, and animals, which consume energy-rich foods. Some kinds of organisms, many of them microscopic, cannot be neatly classified as either plants or animals.

Suggested Activity:

Students work in cooperative groups to design an imaginary microscopic organism. Drawings and explanations are presented to the class. Teams decide whether the organism is a plant or an animal based on the presentations. The teacher and students continually point out fine distinctions and may compare their creation to real organisms such as Euglena.

Embedded Assessment: Observing whether students can defend their decision of plant or animal.

Summative Assessment: Using the data gathered in the activity, students will identify the characteristics of plants and of animals and use them to characterize a mystery specimen* provided by the teacher.

Theme: Models

Process: Developing Explanatory Frameworks, esp. generating novel ideas

***Buying cultures of Euglena and paramecium is suggested for microscopic exam, you may not always get good results from pond water.**

THE LIVING ENVIRONMENT - Diversity of Life
Grade 6-8 (Benchmark 2 of 5)

By the end of 8th grade all students will know that --

Animals and plants have a great variety of body plans and internal structures that contribute to their being able to make or find food and reproduce.

Suggested Activities:

Discuss food tube segmentation. Compare an earthworm's digestive system to the human system. Dissect earthworms and examine. As an alternative, computer simulation may be substituted for actual dissection.

Have students work in groups of four. Each group is given a different 'beak' (clothes pin, chopsticks, tweezers, spoon) and candies or other objects in a variety of shapes. The students are asked to fill their 'stomachs' (a paper cup) with as much food as possible. Discussion should be expanded to include environmental change and food shortages.

Place a cactus and ivy plant in two pots of the same size. Water plants equally. Observe the plants over a period of several weeks and discuss the results.

Embedded Assessment: Students can relate the beak activity to different beaks possessed by real birds.

Summative Assessment: Graphs are made to analyze the beak data, and an analysis of which beak is most efficient for each type of food is made. Given an example of an animal's jaw, the student will be able to infer the type of food the animal eats and something about how it moves.

Theme: Systems

Process: Manipulating Information, esp. developing generalizations

Use the 'WHAT'S IN MY LUNCH BOX' activity from Roger Williams Park Zoo. Along with curriculum materials a kit is provided which contains teeth, claws, feet and beaks from various animals.

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THE LIVING ENVIRONMENT - Diversity of Life
Grade 6-8 (Benchmark 3 of 5)

By the end of 8th grade all students will know that --

Similarities among organisms are found in internal anatomical features, which can be used to infer the degree of relatedness among organisms. In classifying organisms, biologists consider details of internal and external structures to be more important than behavior or general appearance.

Suggested Activity:

Working from similar size photographs or diagrams, make jigsaw puzzles of the wing bones from a bird; the arm bones from a man; the wing bones of a bat; and the flipper bones of a whale. Have students work cooperatively, one puzzle per group. The students need to guess what animal their puzzle depicts. A group discussion of homologous and analogous structures follows.

Embedded Assessment: Given photos of bones the students can identify the type of animal they represent.

Summative Assessment: The children note the similarities and differences among the four puzzles.

Theme: Models

Process: Manipulating Information, esp. identifying patterns and relationships

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THE LIVING ENVIRONMENT - Diversity of Life
Grade 6-8 (Benchmark 4 of 5)

By the end of 8th grade all students will know that --

For sexually reproducing organisms, a species comprises all organisms that can mate with one another to produce fertile offspring.

Suggested Activity:

Do fruitfly mating of different genetic mutants (available from numerous biological supply houses). The teacher explains genetic mating and a Punnett Square.

Embedded Assessment: Children can identify the different types of fruit flies resulting from mating and do a simple Punnett Square.

Summative Assessment: The student's ability to interpret Punnett Squares.

Theme: Models

Process: Developing Explanatory Frameworks, esp. making testable predictions

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THE LIVING ENVIRONMENT - Diversity of Life
Grade 6-8 (Benchmark 5 of 5)

By the end of 8th grade all students will know that --

All organisms, including the human species, are part of and depend on two main interconnected global food webs. One includes microscopic ocean plants, the animals that feed on them, and finally the animals that feed on those animals. The other web includes land plants, the animals that feed on them, and so forth. The cycles continue indefinitely because organisms decompose after death to return food material to the environment.

Suggested Activities:

Set up a pond water system - plankton, fish, snails. Make observations over a period of time.

Set up a mini ecosystem using glass jars, metal lids, soil and 2 or 3 plants (no animals) tightly sealed. Date and set in sunlight (or window sill). Students record observations over entire school year. Demonstrate photosynthesis and explore its role in ecosystems.

Embedded Assessment:	Discuss the making of an ecosystem, what is necessary and what is needed to sustain it.
Summative Assessment:	Relate the mini-ecosystem to the real world.
Theme:	Models
Process:	Developing Explanatory Frameworks, esp. linking concepts/principles

Illustrate a food web by making a large mural and making connections with string.

THE LIVING ENVIRONMENT - Diversity of Life
Grade 9-12 (Benchmark 1 of 2)

By the end of 12th grade all students will know that --

The variation of organisms within a species increases the likelihood that at least some members of the species will survive under changed environmental conditions, and a great diversity of species increases the chance that at least some living things will survive in the face of large changes in the environment.

Suggested Activities:

Group study of -- a) geologic time column; b) map diagrams of earth surface changes; c) paleontological map diagrams of fossil forms; d) peppered moth (Biston betularia) diversity response; e) dinosaur-bird relationship.

Video studies of earth history, species diversification, cell diversification, Charles Darwin, "Life on Earth" by David Attenborough.

Embedded Assessment: Students should discover that diversification and adaptation are constant features throughout time (uniformitarianism). Students should be aware of subtraits within groups of species and that both temporary and permanent environmental change lead to divergent selective traits for survival.

Summative Assessment: Research (written paper, journal writing) on trait diversity in life forms due to changes in climate, plate tectonics, human activity (e.g., accelerating extinctions rates in recent centuries).

Theme: Continuity and Change

Process: Manipulating Information

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THE LIVING ENVIRONMENT - Diversity of Life
Grade 9-12 (Benchmark 2 of 2)

By the end of 12th grade all students will know that --

The degree of kinship between organisms or species can be estimated from the similarity of their DNA sequences, which often closely matches their classification based on anatomical similarities.

Suggested Activity:

Suggested prediscussion of terms and techniques to include DNA, gel electrophoresis, DNA typing. Teacher produces simulated DNA sequences for 5 organisms (incl. man) from various phyla. Groups of students (or individuals) are presented with DNA sequences and attempt to recognize similarities between organisms by correlations in DNA patterns.

Embedded Assessment:	Students recognize organisms which are closely and distantly related.
Summative Assessment:	New DNA simulations can be created by the student after they have been given a description of a 'new' organism. Such simulations indicate student understanding of 'closeness' or 'distance' from already examined DNA sequences.
Theme:	Constancy & Change
Process:	Manipulating Information, esp. identifying patterns and relationships

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THE LIVING ENVIRONMENT - Heredity

Grade K-2 (Benchmark 1 of 2)

By the end of 2nd grade all students will know that --

There is variation among individuals of one kind within a population.

Suggested Activities:

Allow students to experience or examine similar or different games, clothing, colors, heights, etc. Play twenty questions with graphic representation. Take a walk near the school. Look at similar plants (such as trees, flowers or shrubs) and note the similarities and differences within populations.

Embedded Assessment: Sort seeds, sort buttons

Summative Assessment: Sort seeds for subtle differences. Bring in a picture of the person you most resemble and write a story about how you look alike.

Theme: Constancy and Change

Process: Experimental Proficiency, Language Proficiency, Mathematical Proficiency

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THE LIVING ENVIRONMENT - Heredity
Grade K-2 (Benchmark 2 of 2)

By the end of 2nd grade all students will know that --

Offspring are very much, but not exactly, like their parents and like one another.

Suggested Activity:

Given pictures of humans, other animals or plants, students will recognize similarities and differences.

Embedded Assessment: Students should recognize the similarities and the differences among related beings.

Summative Assessment: A discussion of how siblings are both similar to and different from their parents and each other.

Theme: Constancy & Change

Process: Manipulating Information, esp. interpreting/evaluating data

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THE LIVING ENVIRONMENT - Heredity
Grade 6-8 (Benchmark 1 of 3)

By the end of 8th grade all students will know that --

In some kinds of organisms, all the genes come from a single parent, whereas in organisms that have sexes, typically half of the genes come from each parent.

Suggested Activities:

Tongue curling, ear lobe pedigrees. Have students observe root plant cuttings.

Embedded Assessment: Children are able to correctly test themselves in class and note differences between themselves and classmates.

Summative Assessment: Children are able to test and chart relations at home and share pedigree information later in class. (Teachers need to be sensitive to non-traditional families with this activity).

Theme: Constancy and Change

Process: Experimental Proficiency

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THE LIVING ENVIRONMENT - Heredity
Grade 6-8 (Benchmark 2 of 3)

By the end of 8th grade all students will know that --

In sexual reproduction, a single specialized cell from a female merges with a specialized cell from a male. As the fertilized egg, carrying genetic information from each parent, multiplies to form the complete organism with about a trillion cells, the same genetic information is copied in each cell.

Suggested Activities:

Using either picture graphics or models (preferable) present information about sexual reproduction and cell development (eucaryotic) from blastula to gastrula to complete organism. Discuss necessity for differentiation and advantages of specialization for multicellular organism. Use the appropriate segment of the PBS video, "The Universe Within." Optional: discuss differentiation in clonal development and dedifferentiation in cancer development, as well as new reproductive technologies.

Embedded Assessment:

Students interest in and contribution to the discussion.

Summative Assessment:

Students are able to demonstrate either verbally or in writing a basic understanding of sexual reproduction and multicellular organismal development and specialization. They are also able to relate these concepts to their own life and development.

Theme:

Constancy and Change

Process:

Language Proficiency

Collect newspaper and journal articles on the new technologies. Divide the class in half for a debate on the costs/benefits of pursuing these technologies, of making them accessible to the public. All points should be supported with documentation.

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THE LIVING ENVIRONMENT - Heredity
Grade 6-8 (Benchmark 3 of 3)

By the end of 8th grade all students will know that --

New varieties of cultivated plants and domestic animals have resulted from selective breeding for particular traits.

Suggested Activity:

Challenge children to list some pets, garden plants, vegetable and flowers, fruit trees, etc. that they are aware of in their own lives. For example, seedless grapes, new tulip varieties, Himalayan cats, racehorses that result from selective breeding. Discuss the results of this breeding, both advantages and disadvantages. Different types of maize (corn) can also be obtained from a biological supply company - students can plant seeds to see the results of some selective breeding.

Embedded Assessment: Students ability to name some examples of selective breeding that they are aware of in their own lives; students ability to grow and recognize maize (corn) selective breeds.

Summative Assessment: Students can discuss in detail pros and cons of selective breeding and relate this practice to everyday life.

Theme: Constancy & Change

Process: Experimental Proficiency

For a discussion on Dutch Elm disease, contact Paul Dolan at DEM. Information about animal and plant breeds from Colonial days can be obtained from Roger Williams Park Zoo or Plimoth Plantation (1-508-746-1622, ext. 356) in Massachusetts.

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THE LIVING ENVIRONMENT - Heredity
Grade 9-12 (Benchmark 1 of 6)

By the end of 12th grade all students will know that --

Some new gene combinations make little difference, some can produce organisms with new and perhaps enhanced capabilities, and some can be deleterious.

Suggested Activity:

Suggested prediscussion of various types of mutation such as deletion and transposition. Students are presented with a human DNA fragment representing a normal gene and are asked to determine the amino acid sequence. New DNA fragments are transcribed and then translated to determine the order of amino acids. Students note any differences when comparing the new fragments to the original. Students describe what effects they think will result from the changes. (Contact Pam Fontaine at LaSalle Academy in Providence for more details on this activity.)

Embedded Assessment: Students are able to recognize changes between the original and new fragments and are able to transcribe and translate the DNA to an amino acid.

Summative Assessment: New DNA fragments are given to students to take home, examine and compare to normal DNA fragments. Students must identify the mutated fragment, mark the region of mutation and explain why they believe the fragment to be mutated.

Theme: Constancy & Change

Process: Manipulating Information

Use DNA/RNA model kits and codon charts to illustrate these areas.

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THE LIVING ENVIRONMENT - Heredity
Grade 9-12 (Benchmark 2 of 6)

By the end of 12th grade all students will know that --

The sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations from the offspring of any two parents.

Suggested Activity:

Students will work in pairs. They will be given a list of at least 12 different physical characteristics. A chart will describe the phenotype of homozygous dominant, recessive and heterozygous conditions. Students assume they are parents who are heterozygous for each trait listed. Both students flip coins to determine the genotype of their child - 2 heads homozygous dominants, 1 head 1 tail a hybrid, etc. When finished obtaining data, each pair of parents will draw their offspring. Class will compile a list of gene frequencies for each trait listed.

Embedded Assessment:	Students are able to flip the coins and determine whether the offspring are homozygous dominant, homozygous recessive, etc. and predict offspring phenotype. Drawing of 'child' accurately reflects coin data.
Summative Assessment:	Students can examine display offspring, counting frequency of the 12 traits. Students decide the frequency (4/12, 6/12, etc.) of traits and determine which trait is dominant, etc. and compare with expected phenotypic ratios.
Theme:	Constancy and Change
Process:	Manipulating Information, esp. interpreting/evaluating

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THE LIVING ENVIRONMENT - Heredity
Grade 9-12 (Benchmark 3 of 6)

By the end of 12th grade all students will know that --

The information passed from parents to offspring is coded in DNA molecules.

Suggested Activities:

Students are given a specific segment of DNA and they duplicate it to produce identical sequences. Students then create their own 3-D models of both the original fragment and the replicated pair.

A second activity is to show students how to construct a Punnett square for height in pea plants (Tt), ABO blood groups (dominant, recessive and co-dominant), cystic fibrosis, etc.

Embedded Assessment: Students recognize that in this case the original DNA fragment was copied exactly into 2 new strands.

Summative Assessment: Teacher presents the background of a specific disease such as PKU to the students. The gene fragment with the mutation is compared to the normal sequence by the students. Students discuss the difference(s) between the 'normal' and 'PKU' fragment in writing. Students describe the amino acid change(s) in the PKU fragment as compared to the normal and correctly surmise that gene changes must have been present in the parental DNA.

Theme: Constancy and Change

Process: Manipulating Information

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THE LIVING ENVIRONMENT - Heredity
Grade 9-12 (Benchmark 4 of 6)

By the end of 12th grade all students will know that --

Genes are segments of DNA molecules. Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring's success in its environment.

Suggested Activity:

Teacher pre-discusses STOP codons and their relationship to mutations. Students are given two very similar gene fragments. One fragment differs from the other only in one base (A for T, for example). Students determine the codon sequence for each fragment, noting that both gene fragments code for the same amino acids. Two new gene fragments are given to students with one fragment differing from the other in only one amino acid again (different location). Students determine the codon sequence for each fragment, noting that this time there is a change in the coding of amino acids.

Embedded Assessment: Students recognize that small alterations in DNA sequences may have no or some effect on the resulting amino acid sequence.

Summative Assessment: Students are presented with four new DNA fragments, one coded as 'original', and sequence the amino acids. Students are asked to predict whether the changes from the original will have no, little, or deleterious effect based on prior knowledge and experience.

Theme: Constancy and Change

Process: Manipulating Information

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THE LIVING ENVIRONMENT - Heredity
Grade 9-12 (Benchmark 5 of 6)

By the end of 12th grade all students will know that --

Gene mutations can be caused by such things as radiation and chemicals. When they occur in sex cells, the mutations can be passed on to offspring; if they occur in other cells, they can be passed on to descendant cells only. The experiences an organism has during its lifetime can affect its offspring only if the genes in its own sex cells are changed by the experience.

Suggested Activity:

Students research one particular somatic and one particular germ cell mutation.

Embedded Assessment:

Student understands the concept of mutation and can distinguish between germ and somatic cell changes.

Summative Assessment:

Four examples of mutations provided by student research are presented to other students. Students must determine which are germ and which are somatic mutations and must defend their choices.

Theme:

Constancy and Change

Process:

Manipulating Information

Contact a Genetic Counselor (Dr. Dianne Abuelo at Rhode Island Hospital, 444-8361) to use as a resource. Have the class read and discuss Rachel Carson's Silent Spring in terms of gene mutations due to toxic chemicals.

THE LIVING ENVIRONMENT - Heredity
Grade 9-12 (Benchmark 6 of 6)

By the end of 12th grade all students will know that --

The many body cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions. Different genes are turned on and other genes are repressed as cells develop and specialize.

Suggested Activity:

Carrot callus and differentiation media can be ordered from biological supply houses and students can see that a mature specialized cell can give rise to a new carrot embryo clone just as a carrot seed can. The teacher can show liver, skin, lung, etc. and then raise questions about how these specialized cells all developed from the same fertilized egg. A visit to a histology and/or cytology laboratory could also be scheduled.

Embedded Assessment:	Students actively participate in discussion and raise pertinent questions about how genes are turned on and how they are repressed.
Summative Assessment:	Students are able to generalize this concept to fetal development, plant cloning and such pathological processes as cancer.
Theme:	Constancy and Change
Process:	Manipulating Information, esp. developing generalizations

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THE LIVING ENVIRONMENT - Cells
Grade 6-8 (Benchmark 1 of 4)

By the end of 8th grade all students will know that --

All living things are composed of cells, from just one to many millions, whose details usually are visible only through a microscope. Different body tissues and organs are made up of different kinds of cells. The cells in similar tissues and organs in other animals are similar to those in human beings but differ somewhat from cells found in plants.

Suggested Activity:

Examine plant, animal and bacterial cells using microscope and prepared slides (or alternatively microviewers). Students should draw and label these different cells or label prepared diagrams about how these cells differ from each other and how they are similar. Have students prepare their own slides of cells.

Embedded Assessment: Students are able to recognize similarities and differences between procaryotes (bacteria) and eucaryotes (plants and animals).

Summative Assessment: Presented with several slides of plant, animal and bacterial cells which are unfamiliar, students can correctly identify the appropriate kingdoms.

Theme: Systems

Process: Experimental Proficiency

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THE LIVING ENVIRONMENT - Cells
Grade 6-8 (Benchmark 2 of 4)

By the end of 8th grade all students will know that --

Cells continually divide to make more cells for growth and repair. Various organs and tissues function to serve the needs of cells for food, air, and waste removal.

Suggested Activity:

Examine yeast cultures (such as used in micro-breweries) to show cell growth (budding) and division; Planaria culture - part of planaria can be cut off and the planaria will regenerate.

Embedded Assessment: Students observe and describe how the yeast culture grows and divides. Students observe and describe how planaria regenerates.

Summative Assessment: Students are able to write a small report complete with diagrams about the similarities and differences between single cell growth (yeast) and multicellular (planaria) growth and replacement. Other questions - such as how long the yeast culture took to divide vs. regeneration of planaria can be asked.

Theme: Scale

Process: Experimental Proficiency

Teams of students, in cooperation with the culinary arts/cafeteria staff, should make their own bread. Select different recipes where rising time for yeast varies. Students should observe, time and record time cycles for the rising process and the conditions that affect them. Students should chart the relationship between the variables. A visit to a local bakery/restaurant should be included so students understand the impact of this timing process in the workplace and for employees who rise before dawn.

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THE LIVING ENVIRONMENT - Cells
Grade 6-8 (Benchmark 3 of 4)

By the end of 8th grade all students will know that --

Within cells, many of the basic functions of organisms--such as extracting energy from food and getting rid of waste--are carried out. The way in which cells function is similar in all living organisms.

Suggested Activity:

Set up 3-4 yeast cultures using the same amount of water (e.g., 100 ml, 200 ml, or 500 ml) in each of the 3-4 beakers. Then vary the amount of sucrose (table sugar), 1 gram in 1 beaker, etc. Students describe growth density of yeast over 2-3 day period. Students then draw conclusions concerning food availability and waste build-up on the yeast culture growth. Collect data and graph results.

Embedded Assessment: Students are able to read and follow directions on how to set up cultures.

Summative Assessment: Students are able to describe the growth differences between the cultures. Students are also able to relate the culture's growth to environmental problems of food availability, population growth and waste removal.

Theme: Models

Process: Experimental Proficiency

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THE LIVING ENVIRONMENT - Cells
Grade 6-8 (Benchmark 4 of 4)

By the end of 8th grade all students will know that --

About two thirds of the weight of cells is accounted for by water, which gives cells many of their properties.

Suggested Activity:

Using onion cells (peel thin layer from onion) have students treat the onion cells on microscope slides with water; isotonic saline; hypertonic saline solution. Students observe the effect each solution has on their onion cells (using the microscope). Using potato slices in 3 solutions, demonstrate turgor pressure and compare to what may happen in animal cells.

Embedded Assessment: Students are able to follow directions, make three different onion cell slides, treat them with respective solutions and note the results from the water, isotonic and hypertonic solutions.

Summative Assessment: The students are able to correctly describe and discuss their results. They can generalize about cell structures (cell wall) that are needed to protect cells from the environment.

Theme: Systems

Process: Experimental Proficiency

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THE LIVING ENVIRONMENT - Cells
Grade 9-12 (Benchmark 1 of 8)

By the end of 12th grade all students will know that --

Every cell is covered by a membrane that controls what can enter and leave the cell. In all but quite primitive cells, a complex network of proteins provides organization and shape and, for animal cells, movement.

Suggested Activity:

Students cut a certain length of dialysis tubing closed at one end with string and filled about half full of starch solution (known quantity). A beaker of water (known quantity) is prepared. Dialysis tubing is closed with string and placed in beaker. After 24 hours, the dialysis tubing is examined for change in volume (by eye), tube is cut open and contents measured. The contents of the beaker are also measured. The water solution may be colored to show the movement. Various solutions may be tried to show that some molecules (due to size) cannot move in and out of dialysis membrane. The starch solution may be placed in the beaker and the water in the dialysis tubing to reinforce this concept.

Embedded Assessment:	The student successfully observes changes in volume in beaker and tubing and identifies movement of solution either in or out.
Summative Assessment:	Students repeat experiment using unknown protein or other solution. The students can make hypotheses about the cause of solution movement or lack of movement.
Theme:	Models
Process:	Manipulating Information, esp. inferring

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THE LIVING ENVIRONMENT - Cells
Grade 9-12 (Benchmark 2 of 8)

By the end of 12th grade all students will know that --

Within the cell are specialized parts for the transport of materials, energy capture and release, protein building, waste disposal, information feedback, and even movement. In addition to these basic cellular functions common to all cells, most cells in multicellular organisms perform some special functions that others do not.

Suggested Activities:

Students observe and draw a variety of single-celled organisms or single cells in tissue (paramecium, Euglena, onion, etc.). Students observe various organelles and the similarities and differences between specimens. Use relevant portions of the PBS video, "The Universe Within."

Embedded Assessment:	Students successfully identify common and different characteristics in the biological samples.
Summative Assessment:	Students are asked to develop an organism suited to a particular environment (selected by the teacher). Organelles should be listed and then a description given which explains the survival benefit of each organelle.
Theme:	Models
Process:	Developing Explanatory Frameworks, esp. creating/testing mental models

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THE LIVING ENVIRONMENT - Cells
Grade 9-12 (Benchmark 3 of 8)

By the end of 12th grade all students will know that --

The work of the cell is carried out by the many different types of molecules it assembles, mostly proteins. Protein molecules are long, usually folded chains made from 20 different kinds of amino-acid molecules. The function of each protein molecule depends on its specific sequence of amino acids and the shape the chain takes is a consequence of attractions between the amino acids in the chain.

Suggested Activity:

Use transparencies (overhead) to show students the structure of different proteins (egg albumin, insulin, hemoglobin) in their active shape. Take fresh egg albumin (egg white) and heat it up. Students should record observed changes in albumin. Using fresh egg albumin, place the albumin in dilute HCl (0.1M). Students should record observed changes in albumin. Teacher then discusses how heat, acid, etc. can break H-bonds in proteins, resulting in denaturation which causes a change in protein shape and consistency.

Embedded Assessment: Students are involved in the activity and the discussion. They can make correct assessments about the experimental results.

Summative Assessment: The students are able to generalize about other environmental effects on proteins (i.e., how UV light and sunburn affect their skin) in writing.

Theme: Models

Process: Developing Explanatory Frameworks

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THE LIVING ENVIRONMENT - Cells
Grade 9-12 (Benchmark 4 of 8)

By the end of 12th grade all students will know that --

The genetic information in DNA molecules provides instructions for assembling protein molecules. The code used is virtually the same for all life forms.

Suggested Activity:

Using DNA/RNA/Protein model kits (from a biological supply house) the students are given a particular DNA sequence (nonsense strand). The students, working in pairs or small groups, must build the DNA model, the m-RNA and finally must construct the protein (students are also given a codon sheet).

Embedded Assessment:	Students are able to take a DNA sequence from given information and build it, along with its complementary strand - make the correct m-RNA and then determine the sequence of amino acids coded for by the m-RNA.
Summative Assessment:	The students are able to describe and discuss DNA synthesis, transcription and translation. If they make a mistake in their model building they can generalize about the consequences (mutations) if the mistake was made in a real cell.
Theme:	Models
Process:	Developing Explanatory Frameworks

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THE LIVING ENVIRONMENT - Cells
Grade 9-12 (Benchmark 6 of 8)

By the end of 12th grade all students will know that --

Gene mutation in a cell can result in uncontrolled cell division, called cancer. Exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer.

Suggested Activity:

Using DNA/RNA model kits and codon charts, students will be given a DNA sequence to construct (30-45 DNA nucleotides). Then they will construct the m-RNA and the final protein. Students will then be asked to make a transversion, substitution and deletion somewhere in the original DNA and then show the changes which occur in the RNA and final protein. Since class members can choose the locations of their mutations, final class results will vary. A class summary can be prepared.

Embedded Assessment:	Students observe a relationship between DNA mutations and the structure of the final protein.
Summative Assessment:	Using class data students will be asked to explain which mutations in DNA have the most profound effect on the final protein structure and must defend their position.
Theme:	Models
Process:	Experimental Proficiency, esp. identifying variables

Purchase irradiated and non-irradiated seeds from a biological supply house. Investigate the implications of ingestion of various chemicals, pesticides, etc. Class groups should do research using computer resources, interviews (with dietitians, oncologists, nutritionists) on various types of cancer. This should culminate in a jigsaw sharing which would not only detail various possible cancer causes/effects, but also emphasize some already discovered cancer prevention strategies.

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THE LIVING ENVIRONMENT - Cells
Grade 9-12 (Benchmark 7 of 8)

By the end of 12th grade all students will know that --

Most cells function best within a narrow range of temperature and acidity. At very low temperatures, reaction rates are too slow. High temperatures and/or extremes of acidity can irreversibly change the structure of most protein molecules. Even small changes in acidity can alter the molecules and how they interact. Both single cells and multicellular organisms have molecules that help to keep the cell's acidity within a narrow range.

Suggested Activity:

Have students conduct an experiment involving BOD (biological oxygen demand) using methylene blue or similar indicator (bromthymol blue) with yeast in milk. Use 3 temperatures: 20°C, 37°C, 55°C. Have student note differences in oxidation as function of temperature - and at higher temperature, denaturation effects should be noted. For another activity use similar yeast cultures (3) and vary pH using levels of 7.0, 5.0, and 2.0.

Embedded Assessment:

Students are able to observe that changes in pH and temperature directly affect the ability of the yeast cells to effectively oxidize methylene or bromthymol blue.

Summative Assessment:

When students are presented with a new hypothetical situation such as yeast culture kept at a narrower temperature (or pH) range, students are able to predict what will happen to the yeast cultures and can defend their predictions.

Theme:

Constancy and Change

Process:

Manipulating Information, esp. identifying patterns and relationships

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THE LIVING ENVIRONMENT - Cells
Grade 9-12 (Benchmark 8 of 8)

By the end of 12th grade all students will know that --

A living cell is composed of a small number of chemical elements, mainly carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur. Carbon, because of its small size and four available bonding electrons, can join to other carbon atoms in chains and rings to form large and complex molecules.

Suggested Activity:

Students can create a variety of organic molecules using model kits, gumdrops and toothpicks, etc.

Embedded Assessment: Students understand the basis of organic molecules and can construct molecules with appropriate numbers of atoms and bonds.

Summative Assessment: Students construct an organic ring molecule at home and explain its structure.

Theme: Models

Process: Psychomotor Proficiency

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THE LIVING ENVIRONMENT - Interdependence of Life
Grade K-2 (Benchmark 1 of 2)

By the end of 2nd grade all students will know that --

Animals eat plants or other animals for food and may also use plants (or even other animals) for shelter and nesting.

Suggested Activity:

Construct a food chain. Construct a habitat which includes the animals' food, shelter and water. Take a walk and collect materials an animal might use to build a nest. Examine ant farms.

Embedded Assessment: Explain the choice of materials for the nest.

Summative Assessment: **Given an animal's habitat, students will explain the relationship between plants and animals.**

Theme: Systems

Process: Experimental Proficiency, esp. observing

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THE LIVING ENVIRONMENT - Interdependence of Life
Grade K-2 (Benchmark 2 of 2)

By the end of 2nd grade all students will know that --

Living things are found in a variety of places everywhere in the world. There are different kinds of living things in different places.

Suggested Activity:

Take students to a woodland area (or a field, the beach, a backyard, etc.). Students will observe living things under a rock, in a tree, and on the edge of a pond or stream.

Embedded Assessment:	Make a terrarium in the classroom with the help of the students and ask students to describe features and changes they observe.
Summative Assessment:	Provide a picture of habitat and ask students to explain who lives on land, water, and air. Explain how they survive.
Theme:	Constancy and Change
Process:	Manipulating Information, esp. developing generalizations

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THE LIVING ENVIRONMENT - Interdependence of Life
Grade 3-5 (Benchmark 3 of 5)

By the end of 5th grade all students will know that --

Organisms interact with one another in various ways besides providing food. Many plants depend on animals for carrying their pollen to other plants or for dispersing their seeds.

From Ms. Arruda's Fifth Grade Class, Babcock Middle School, Westerly ...

By the end of 5th grade, students should know something about the life cycle of plants and how they interact with one another in various ways besides providing food. To help students explore how some organisms satisfy their environmental needs, Ms. Arruda uses the "Exploring with Wisconsin Fast Plants" kit, produced by the Department of Plant Pathology at the University of Wisconsin-Madison and distributed by Carolina Biological Supply Company. The kit comes complete with all the necessary materials to grow 'fast' plants.

This nickname is appropriate, seeing that it only takes 28 days for these Brassica plants to complete their entire life cycle. This kit enables students to experience a plant's complete life style, beginning with a seed and ending with the development of a new seed, which encouraging students to actively participate in the plant's life cycle. For example, students actually use a bee body (attached to a toothpick) to cross pollinate the plants. They rub the thorax of the bee into the flower gathering pollen, then rub the pollen onto the flower parts of another flower, thus cross pollinating the plants. The students absolutely love learning about plants in this manner, and the activity orientation of the lessons helps to make them positive and meaningful.

Embedded Assessment: Students can explain the process of pollination using their actions in the lab as an analogue.

Summative Assessment: Students can identify three examples within their environment which illustrate the elements of this benchmark and explain their selections.

Theme: Models

Process: Experimental Proficiency, Psychomotor Proficiency

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THE LIVING ENVIRONMENT - Interdependence of Life
Grade 6-8 (Benchmark 1 of 2)

By the end of 8th grade all students will know that --

In all environments--freshwater, marine, forest, desert, grassland, mountain, and others--organisms with similar needs may compete with one another for resources, including food, space, water, air, and shelter. In any particular environment, the growth and survival of organisms depend on the physical conditions.

Suggested Activity:

Give each team of students 2 petri dishes. Place wet paper towels on the bottom of the petri dishes. Place 6 to 8 seeds in one dish, place 30-40 seeds in the other. Make sure watering is equal and minimal.

Embedded Assessment: Predict development in each petri dish and justify your reason.

Summative Assessment: Explain why a farmer plants 4/5 seeds per hill and later returns to thin seedlings. Why didn't he just plant 1 seed per hill? Why did he not let all the seedlings remain?

Theme: Systems

Process: Manipulating Information, esp. connecting new information with previous knowledge

Take a trip to the zoo. Observe animals that share the same environment and those that are housed alone. Discuss observations. Use the activity "Quick Frozen Critters" from Project Wild (contact Chris Dudley at 783-7490). Contact URI's Learning Landscape at 792-2900 for relevant environmental education programs.

THE LIVING ENVIRONMENT - Interdependence of Life
Grade 6-8 (Benchmark 2 of 2)

By the end of 8th grade all students will know that --

Two types of organisms may interact with one another in several ways: they may be in a producer/consumer, predator/prey, or parasite/host relationship. Or one organism may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other.

Suggested Activity:

Videos (e.g. National Geographic series), pictures, photographs, nature walks. Utilize any or all of the above to identify relationships.

Embedded Assessment:	Identify and label relationships in each activity.
Summative Assessment:	Given a list of randomly organized names or organisms, have students match organisms and describe or label their relationship.
Theme:	Systems
Process:	Manipulating Information, esp. identifying patterns and relationships

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THE LIVING ENVIRONMENT - Interdependence of Life
Grade 9-12 (Benchmark 1 of 3)

By the end of 12th grade all students will know that --

Ecosystems can be reasonably stable over hundreds or thousands of years. As any population of organisms grows, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to increased numbers of predators, or parasites. If a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages that eventually result in a system similar to the original one.

Suggested Activity:

Students research a well-known ecological disaster (such as Mt. St. Helen's eruption, DDT and bird populations, mid-Western floods of '93, Yellowstone Fire, or other current events). Research should discuss damage to ecosystem and recovery progress to date.

Embedded Assessment: Students demonstrate understanding of ecosystems and effects of change on such systems and system recovery.

Summative Assessment: Teacher provides ecosystem and change which affects it. Students are asked to predict recovery or decline of ecosystem over a defined period.

Theme: Constancy & Change

Process: Problem Solving Proficiency

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THE LIVING ENVIRONMENT - Interdependence of Life
Grade 9-12 (Benchmark 2 of 3)

By the end of 12th grade all students will know that --

Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution.

Suggested Activity:

Students are presented with a summary of the gypsy moth infestation of the early 1980's. Students are asked to interview older family members, friends, community members about the infestation. Students will record such information as gypsy moth numbers, moth physical appearance, damage to bushes and trees, refoliation of trees, home remedies to kill moths, town remedies. Conduct related discussions of deer tick and 'killer' bee populations.

Embedded Assessment: Students understand the nature of the infestation by using primary and secondary sources and successfully record information.

Summative Assessment: Students are to respond to the questions, "Do you believe another infestation is possible?" and defend their response. If there was another infestation, what would they do to control the infestation?

Theme: Constancy & Change

Process: Proficiency in Reaching Decisions About Issues

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**From Mr. Rapose
Pilgrim High School
Warwick, Rhode Island
High School Activity**

The Two Liter Ecosystem

In this activity students observe, record and create hypotheses while experimenting with a self-contained ecosystem in a two liter bottle. To begin the activity the teacher must collect bean, tomato, squash and pea seeds, potting soil, and clear two liter bottles. The seeds should be germinated by laying them on a wet paper towel cut to fit inside a petri dish. Two of each type of seed should be germinated in each petri dish, which should be placed in a sunny area for about a week. Once the plants begin to sprout the students plant one of each type of seed in an open two liter bottle (cut the top half off). Students should be given a fixed amount of soil and water to be used in their ecosystem. The seeds should be planted in the bottle about one inch deep in the soil. The bottles are then sealed by re-joining the top half to the bottom with clear tape.

Over the course of about four weeks students make daily observations of any action occurring in their ecosystem. They record changes such as the movement of water inside the bottle (water cycle) and the rate of plant growth. They may observe that some plants will flourish, while others will die out. As they work together in groups they may discuss things such as evaporation, cloud formation, plants bending toward the sunlight, and the effect of gases on the ecosystem. I use the ecosystem activity to introduce many ecological ideas, such as limited resources, competition, and the hydrological cycle.

By the end of the fifth week the ecosystem begins to break down, and students can observe the growth of molds and the browning of the plant leaves. At this point students are asked to speculate why their once healthy ecosystems are beginning to decay. In some of the ecosystems small bugs begin to appear. This always amazes the students.

As the ecosystem continues to break down, students work in teams to create a report explaining what they learned from the activity. I supply them with some leading questions and help them get started.

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THE LIVING ENVIRONMENT - Interdependence of Life
Grade 9-12 (Benchmark 3 of 3)

By the end of 12th grade all students will know that --

Human beings are part of the earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

Suggested Activity:

Have students choose a local issue of interest. Divide the group into different roles. Have them take on identities as foresters, developers, store owners, and environmentalists. See if they can work out use of the land so that it is environmentally balanced. The results of this activity will be class adoption of a problem that needs to be addressed. Student teams will devise a plan of action based on scientific knowledge, survey of existing research, and action steps. This will be a jigsaw cooperative learning opportunity. Major responsibility areas should include research, interview, follow-up, document preparation, and presentation to community groups.

Embedded Assessment: Students are able to recognize the effect of human activity on ecosystems and can contemplate repairing any damage to the ecosystem.

Summative Assessment: Students interview a person in their school or community regarding potential ecological hazards existing in the individuals school, business, town. Student reports findings orally to class. Students also report on human activity within a community which has had a positive effect on a local ecological community.

Theme: Systems

Process: Proficiency in Informed Action

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THE LIVING ENVIRONMENT - Flow of Matter and Energy
Grade 6-8 (Benchmark 1 of 3)

By the end of 8th grade all students will know that --

Food provides the fuel and the building material for all organisms. Plants use the energy from light to make sugars from carbon dioxide and water. This food can be used immediately or stored for later use. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms.

Suggested Activities:

Energy and Biomass Pyramids: assign each group of students an ecosystem and have them develop pyramids for their system.

Grow 2 sets of bean seeds, one on the classroom windowsill and one in a dark closet. Keeping all other variables equal, observe differences and similarities.

Embedded Assessment:	Construct and compare energy and biomass pyramids for their given ecosystem.
Summative Assessment:	Have students imagine they are eating a fast food hamburger. Have them trace the materials and the energy back through the food chains.
Theme:	Systems
Process:	Manipulating Information, esp. identifying patterns and relationships

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THE LIVING ENVIRONMENT - Flow of Matter and Energy
Grade 6-8 (Benchmark 2 of 3)

By the end of 8th grade all students will know that --

Over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.

Suggested Activity:

Biomass Pyramid: trace matter - take the biomass pyramid developed in Benchmark 1 of 3 in this section and trace what happens to matter as it moves through the pyramid.

Embedded Assessment: How does this principle apply to the biosphere?

Summative Assessment: Have students imagine they are eating a fast food hamburger. Have them trace the materials and the energy back through the food chains.

Theme: Systems

Process: Developing Explanatory Frameworks, esp. linking concepts and principles

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THE LIVING ENVIRONMENT - Flow of Matter and Energy
Grade 6-8 (Benchmark 3 of 3)

By the end of 8th grade all students will know that --

Energy can change from one form to another in living things. Animals get energy from oxidizing their food, releasing some of its energy as heat. Almost all food energy comes originally from sunlight.

Suggested Activity:

Biomass Pyramid: trace matter - take the biomass pyramid developed in Benchmark 1 of 3 in this section and trace what energy transfer and loss happens.

Embedded Assessment:

Check to see that students can explain that energy can be changed to heat/movement or transferred to another organism in the chain.

Summative Assessment:

Have students imagine they are eating a fast food hamburger. Have them trace the materials and the energy back through the food chains.

Theme:

Systems

Process:

Developing Explanatory Frameworks, esp. linking concepts and principles

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THE LIVING ENVIRONMENT - Flow of Matter and Energy
Grade 9-12 (Benchmark 1 of 3)

By the end of 12th grade all students will know that --

At times, environmental conditions are such that plants and marine organisms grow faster than decomposers can recycle them back to the environment. Layers of energy-rich organic material have been gradually turned into great coal beds and oil pools by the pressure of the overlying earth. By burning these fossil fuels, people are passing most of the stored energy back into the environment as heat and releasing large amounts of carbon dioxide.

Suggested Activity:

A speaker from Narragansett Electric speaks to the class about coal-generated electricity, renewable and non-renewable resources, use of electricity in the home. Included will also be a discussion of the waste generated by burning coal. Video should be shown to class regarding fossil fuel electricity generation. The issues of fuel consumption, waste generation, electricity consumption should be included in a class discussion.

Embedded Assessment:	Students understand how electricity is produced from fossil fuels and the implications to the environment from consumption of fossil fuels.
Summative Assessment:	Student writes a short paper which relates fossil fuel consumption to the average temperature of the earth and the overall 'greenhouse' effect.
Theme:	Systems
Process:	Proficiency in Informed Action, esp. describing current practice/policy

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THE LIVING ENVIRONMENT - Flow of Matter and Energy
Grade 9-12 (Benchmark 2 of 3)

By the end of 12th grade all students will know that --

The amount of life any environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the residue of dead organic materials. Human activities and technology can change the flow and reduce the fertility of the land.

Suggested Activities:

Each pair of students prepares a 2L soda bottle 'growing system' to contain potting soil, radish plants, or other 'fast' plants. The teacher prepares various dilutions of standard houseplant fertilizer. Each pair of students receives a different dilution of fertilizer. All the bottles receive the same amount of sunlight, heat, water, and fertilizer. Students observe open bottles over a designated period recording germination time, height, leaf size, leaf color, and the death of the plant (if applicable). At the end of the experiment, students pool and graph class data for concentration of fertilizer versus other characteristics.

As an additional activity have each pair of students prepare a 2L soda bottle with potting soil, water, grass clippings, and leaves (preferably dry) on top of the soil. Bottles are left open and observed over a designated period to document changes in the clippings and leaves.

Embedded Assessment: Students properly tend 'gardens' and understand the relationship between fertilizer concentration and growth and health of plants.

Summative Assessment: Students construct and explain graphs and decide optimum (best) concentration of fertilizer for each characteristic. Students explain how overfertilization can be injurious to plants and how dependence on artificial fertilizers eventually depletes the land.

Theme: Systems

Process: Developing Explanatory Frameworks

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THE LIVING ENVIRONMENT - Flow of Matter and Energy
Grade 9-12 (Benchmark 3 of 3)

By the end of 12th grade all students will know that --

The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures but much is dissipated into the environment as heat. Continual input of energy from sunlight keeps the process going.

Suggested Activity:

Teacher generates carbon cycle by proposing to students that a single C atom can be recycled time and time again. By question and answer, students generate movement of carbon from one organic molecule to another until the carbon moves through the entire cycle. Teacher must stress that the cycle is driven by the sun.

Embedded Assessment:	Students understand the C cycle and how the cycle is driven by the sun.
Summative Assessment:	Students attempt to determine the water cycle using prior knowledge and the description of the C cycle. Students write a summary of the path of a single molecule of water through a cycle.
Theme:	Systems
Process:	Manipulating Information, esp. identifying patterns and relationships

A good reference for this benchmark is the Education in Global Change project, Joseph P. Stoltman, Department of Geography, Western Michigan University, Kalamazoo, MI 49008-5053; (616) 387-3429. Curriculum materials on global change developed under the auspices of the International Council of Scientific Unions.

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THE LIVING ENVIRONMENT - Evolution of Life
Grade K-2 (Benchmark 1 of 2)

By the end of 2nd grade all students will know that --

Different plants and animals have external features that help them thrive in different kinds of places.

Suggested Activity:

Match animals and plants with environments such as cactus with desert; fish or seaweed with water; polar bear with snow; banana tree or monkey with tropics; elephant or grass with plains. Given a habitat and basic body, students can be asked to choose features and 'build the bird' or 'build the tree'.

Embedded Assessment: Students note characteristics and/or features that help them live in that environment.

Summative Assessment: Construct a home for a bird and write a story about how the home protects the bird. Compare the home of a bird with the home of a cat.

Theme: Systems

Process: Language Proficiency

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THE LIVING ENVIRONMENT - Evolution of Life
Grade 6-8 (Benchmark 1 of 3)

By the end of 8th grade all students will know that --

Small differences between parents and offspring can accumulate (through selective breeding) in successive generations so that descendants are very different from their ancestors.

Suggested Activity:

Discuss examples of the selective breeding of plants and animals for a particular use (e.g., sheep - meat vs. wool, horses - speed vs. power). Disease resistant food crops. Have a horticulturist visit your school with different plants.

Embedded Assessment: See if students have examples from their experiences.

Summative Assessment: There is a \$100,000 reward for the first person to develop a black tulip. Explain the biological processes you would use to attempt to win this prize. These tulips must be able to produce further generations of black tulips.

Theme: Constancy and Change

Process: Developing Explanatory Frameworks, esp. linking concepts and principles

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THE LIVING ENVIRONMENT - Evolution of Life
Grade 6-8 (Benchmark 2 of 3)

By the end of 8th grade all students will know that --

Individual organisms with certain traits are more likely than others to survive and have offspring. Changes in environmental conditions can affect the survival of individual organisms and entire species.

Suggested Activity:

Take a variety of seeds (e.g., corn, beans, etc.) and upon germination transplant into 2 containers. Put 1/2 in a different environment from the original and observe the changes.

Embedded Assessment: Have students keep a daily record of changes in seedlings. Write up a lab report after a specified time.

Summative Assessment: Your community has experienced many years of Gypsy moth infestation. Describe this forest's composition of trees 5 years later.

Theme: Constancy and Change

Process: Manipulating Information, esp. interpreting and evaluating data

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THE LIVING ENVIRONMENT - Evolution of Life
Grade 6-8 (Benchmark 3 of 3)

By the end of 8th grade all students will know that --

Many thousands of layers of sedimentary rock provide evidence for the long history of the earth and for the long history of changing life forms whose remains are found in the rocks. More recently deposited rock layers are more likely to contain fossils resembling existing species.

Suggested Activity:

Search for sandstone, shale and slate rocks in your area. Examine them for fossils. Prepare a baby food jar with a screw top lid. Inside place equal amounts of clay, sand, gravel, and pebbles. Add water, and shake vigorously. Students should allow it to settle.

- Embedded Assessment: Have students draw a cross section (labeled) to show which layer settled first, second, etc.
- Summative Assessment: You are helping dig a hole in your yard for a basketball hoop - while digging you uncover assorted animal remains. Describe the system that you would use to determine which was the oldest and which was the youngest.
- Theme: Constancy and Change
- Process: Manipulating Information, esp. inferring

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THE LIVING ENVIRONMENT - Evolution of Life
Grade 9-12 (Benchmark 1 of 9)

By the end of 12th grade all students will know that --

The basic idea of biological evolution is that the earth's present-day species developed from earlier, distinctly different species.

Suggested Activity:

Lecture/discussion on evolution (e.g., from single cells to porifera to coelenterates to worms to echinoderms to chordates). Stress one particular system, such as the evolution of the circulatory system from contractile vessel (worms) to 2 chambered heart (fish) to 3 chambered heart (amphibians) to 4 chambered heart (birds, mammals).

Embedded Assessment: Students will be able to discuss current understanding the evolutionary relationship of major groupings of the animal world.

Summative Assessment: Students will be able to create an evolutionary tree diagram, which depicts six different organisms and their assumed evolutionary relationship to each other.

Theme: Constancy and Change

Process: Manipulating Information, esp. developing generalizations

THE LIVING ENVIRONMENT - Evolution of Life
Grade 9-12 (Benchmark 2 of 9)

By the end of 12th grade all students will know that --

Molecular evidence substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched off from one another.

Suggested Activities:

Students are presented with paper strips containing amino acid sequences of closely related species such as man, chimpanzee, gorilla, orangutan, etc. Students 'correlate' strips, noting similarities and differences between the DNA strips and determine the degree of correlation between them. Explore with students in a general way the limitations of this technique.

An additional activity would be to use an overhead and/or handouts to show an evolutionary tree constructed from the number of amino acid differences between cytochrome C (a highly conserved protein) molecules of different species -- going from plants to fungi to mammals.

Embedded Assessment: Students recognize that some of the species are more genetically related than others because of the degree of correlation.

Summative Assessment: Students are presented with another paper strip of an organism related to man. Students are to determine the degree of correlation to man and the other organisms studied previously. Students must decide which organism studied is closest, in an evolutionary sense, to the 'unknown' and defend their choice.

Theme: Systems

Process: Developing Explanatory Frameworks, esp. making testable predictions/attempting refutations

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THE LIVING ENVIRONMENT - Evolution of Life
Grade 9-12 (Benchmark 3 of 9)

By the end of 12th grade all students will know that --

Natural selection provides the following mechanism for evolution: Some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. The proportion of individuals that have advantageous characteristics will increase.

Suggested Activity:

In a local field situation, students observe as many examples of coloration in a particular species as possible in one habitat. Students should postulate as to the various advantages, disadvantages of certain colors in a particular species.

Embedded Assessment: Students will organize observations and derive meaningful conclusions concerning them.

Summative Assessment: Students are to consider the fact that over time, Rhode Island is affected by global warming. Students are to discuss in writing the possible adaptations which might be manifested in plant and/or animal species in Rhode Island. An optional activity might be a laboratory exploration of bacterial resistance to antibiotics.

Theme: Systems

Process: Proficiency in Reaching Decisions about Issues

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THE LIVING ENVIRONMENT - Evolution of Life
Grade 9-12 (Benchmark 4 of 9)

By the end of 12th grade all students will know that --

Heritable characteristics can be observed at molecular and whole-organism levels--in structure, chemistry, or behavior. These characteristics strongly influence what capabilities an organism will have and how it will react, and therefore influence how likely it is to survive and reproduce.

Suggested Activity:

Get albino and regular seeds of the same species (lettuce, radish, etc.) Grow 1/2 of each type in the light and 1/2 of each type in the dark. Compare results.

Embedded Assessment: Discuss the relationship of genotype, phenotype and environmental conditions.

Summative Assessment: Relate this work to a discussion of sickle cell distribution in populations.

Theme: Constancy and Change

Process: Manipulating Information, esp. inferring

Your school nurse should have a great deal of information on sickle cell and other genetic disorders of children. Another excellent resource for information on sickle cell is Betty Leef at Rhode Island Hospital (444-5241). RIH also has a sickle cell social worker and various group meetings on this subject.

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THE LIVING ENVIRONMENT - Evolution of Life
Grade 9-12 (Benchmark 5 of 9)

By the end of 12th grade all students will know that --

New heritable characteristics can result from new combinations of existing genes or from mutations of genes in reproductive cells. Changes in other cells of an organism cannot be passed on to the next generation.

Suggested Activity:

Student will perform standard mitosis and meiosis laboratories.

Embedded Assessment: Students understand the similarities and differences in each process, emphasizing nuclear material in their laboratory discussion.

Summative Assessment: Students explain, in writing, the differences between meiosis and mitosis. Students are presented with a prepared scenario by the teacher in which a hypothetical individual receives whole-body irradiation by X-rays. Students will then predict mutations in various cells, deciding if such mutations will be passed to any potential offspring. Students will defend their predictions.

Theme: Constancy and Change

Process: Experimental Proficiency

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THE LIVING ENVIRONMENT - Evolution of Life
Grade 9-12 (Benchmark 6 of 9)

By the end of 12th grade all students will know that --

Natural selection leads to organisms that are well-suited for survival in particular environments. Chance alone can result in the persistence of some heritable characteristics having no survival or reproductive advantage or disadvantage for the organism. When an environment changes, the survival value of some inherited characteristics may change.

Suggested Activity:

Review appropriate audio visual material about adaptation, such as "Life on Earth" by David Attenborough. Teacher-led discussion can follow about various adaptations that have increased or decreased survival value.

Embedded Assessment: Students understand that not all changes in heritable characteristics create enhanced survival value, while some changes do increase survival value.

Summative Assessment: Discuss the change in survival value that global warming would have on the white snowshoe hare.

Theme: Constancy and Change

Process: Developing Explanatory Frameworks

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